

Appl. No. : **10/614,538**
Filed : **July 3, 2003**

REMARKS

The January 11, 2005 Office Action was based upon pending Claims 1-49. This Amendment amends Claims 1, 13, 25, 34, and 43. Thus, after entry of this Amendment, Claims 1-49 are pending and presented for further consideration.

In the January 11, 2005 Office Action, the Examiner rejected Claims 1-49. In particular, the Examiner rejected Claims 34, 35, and 42-44 under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 4,957,590 ("the Douglas patent"). The Examiner further rejected Claims 1, 2, 8-14, 20-26, 32-35, and 41-44 under 35 U.S.C. § 103(a) as being unpatentable over Japanese Patent Publication No. 06-021440 ("the Abido patent") in view of the Douglas patent. The Examiner further rejected Claims 3-5, 7, 15-17, 19, 27-29, 31, 36-38, 40, 45-47, and 49 under 35 U.S.C. § 103(a) as being unpatentable over the Abido patent in view of the Douglas patent and further in view of U.S. Patent No. 6,376,348 ("the Schrems patent"). The Examiner further rejected Claims 6, 18, 30, 39, and 48 under 35 U.S.C. § 103(a) as being unpatentable over the Abido patent in view of the Douglas patent and further in view of the Schrems patent and U.S. Patent No. 6,097,60 ("the Tsuchida patent").

Reconsideration of the pending claims as amended is respectfully requested.

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT

Submitted concurrently herewith is a Supplemental Information Disclosure Statement citing a new reference, which recently came to Applicant's attention in an Office Action for related U.S. Patent Application No. 10/369,273. In particular, an Office Action for U.S. Patent Application No. 10/369,273 was mailed on December 12, 2005. A copy of this Office Action is available through the Patent Application Information Retrieval (PAIR) system. If the Examiner so requests, Applicants will provide the Examiner with a copy of this Office Action.

While the Applicant does not believe that this reference will affect the patentability of the pending claims, Applicant respectfully requests the Examiner to consider the pending claims in connection with this reference in order to make it of record.

REJECTION OF CLAIMS 34, 35, and 42-44 UNDER 35 U.S.C. § 102(b)

The Examiner rejected Claims 34, 35, and 42-44 under 35 U.S.C. § 102(b) as being anticipated by Douglas. In view of the above claim amendments and the following discussion, Applicant respectfully traverses this rejection.

Claim 34

In an embodiment of the invention, an etch removes titanium oxynitride extrusions protruding from the sides of the titanium silicide layer in a semiconductor stack. The extrusions form by reacting pockets of titanium found in the titanium silicide layer with oxygen and nitrogen from the semiconductor processing steps.

In contrast, Douglas appears to teach forming a titanium oxynitride layer over a titanium silicide layer and etching to remove all filaments of the titanium oxynitride layer from the upper surface of the underlying layer of titanium silicide. Douglas does not teach titanium oxynitride extrusions forming on the exposed sides of the titanium silicide layer by reacting titanium-rich areas of the titanium silicide layer with oxygen and nitrogen from semiconductor processing steps.

The reference cited by the Examiner does not disclose, teach, or suggest a semiconductor stack having at least a side comprising a titanium silicide layer having titanium-rich areas, where the titanium-rich areas form titanium oxynitride in the presence of oxygen and nitrogen. The reference cited by the Examiner does not disclose, teach, or suggest that the titanium oxynitride expands relative to the titanium silicide layer to extend outwardly from the side of the titanium silicide layer to form titanium oxynitride extrusions, and that the titanium silicide layer has substantially etched titanium oxynitride extrusions formed on the side thereof. Applicant asserts that Claim 34 is not anticipated by Douglas. Applicant therefore respectfully submits that Claim 34 is patentably distinguished over the cited references and Applicant respectfully requests allowance of Claim 34.

Claims 35 and 42

Claims 35 and 42, which depend from Claim 34, are believed to be patentable for the same reasons articulated above with respect to Claim 34, and because of the additional features recited therein.

Claim 43

In an embodiment of the invention, an etch removes metal oxynitride extrusions protruding from the sides of the metal silicide layer in a semiconductor stack. The extrusions form by reacting pockets of metal found in the metal silicide layer with oxygen and nitrogen from the semiconductor processing steps.

In contrast, Douglas appears to teach forming a titanium oxynitride layer over a titanium silicide layer and etching to remove all filaments of the titanium oxynitride layer from the upper surface of the underlying layer of titanium silicide. Douglas does not teach metal oxynitride extrusions forming on the exposed sides of the metal silicide layer by reacting metal-rich areas of the metal silicide layer with oxygen and nitrogen from semiconductor processing steps.

The reference cited by the Examiner does not disclose, teach, or suggest a semiconductor stack having at least a side comprising a metal silicide layer having metal-rich areas, where the metal-rich areas form metal oxynitride in the presence of oxygen and nitrogen. The reference cited by the Examiner does not disclose, teach, or suggest that the metal oxynitride expands relative to the metal silicide layer to extend outwardly from the side of the metal silicide layer to form metal oxynitride extrusions, and that the metal silicide layer has substantially etched metal oxynitride extrusions formed on the side thereof. Applicant asserts that Claim 43 is not anticipated by Douglas. Applicant therefore respectfully submits that Claim 43 is patentably distinguished over the cited references and Applicant respectfully requests allowance of Claim 43.

Claim 44

Claim 44, which depends from Claim 43, is believed to be patentable for the same reasons articulated above with respect to Claim 43, and because of the additional features recited therein.

REJECTION OF CLAIMS 1, 2, 8-14, 20-26, 32-35, and 41-44 UNDER 35 U.S.C. § 103(a)

The Examiner rejected Claims 1, 2, 8-14, 20-26, 32-35, and 41-44 under 35 U.S.C. § 103 as being unpatentable over Abido in view of Douglas. In view of the above claim amendments and the following discussion, Applicant respectfully traverses this rejection.

Claims 1 and 13

In an embodiment of the invention, an etch removes metal oxynitride extrusions protruding from the sides of the metal silicide layers in a semiconductor structure. The extrusions form by reacting pockets of metal found in the metal silicide layers with oxygen and nitrogen from the semiconductor processing steps.

In contrast, Douglas appears to teach forming a titanium oxynitride layer over a titanium silicide layer and etching to remove all filaments of the titanium oxynitride layer from the upper surface of the underlying layer of titanium silicide.

Douglas does not teach titanium oxynitride extrusions forming on the exposed sides of the titanium silicide layer by reacting titanium-rich areas of the titanium silicide layer with oxygen and nitrogen from semiconductor processing steps. Douglas does not teach tungsten oxynitride extrusions forming on the exposed sides of the tungsten silicide layer by reacting tungsten-rich areas of the tungsten silicide layer with oxygen and nitrogen from semiconductor processing steps.

Douglas does not teach forming a barrier layer, nor does Douglas teach metal oxynitride extrusions forming on the exposed sides of the semiconductor structure by reacting metal-rich areas of the metal silicide layer with oxygen and nitrogen from semiconductor processing steps. While Abido teaches forming a barrier layer, Abido does not appear to teach any extrusions forming on the semiconductor device.

Thus, there is no suggestion or motivation to combine the Douglas reference with the Abido reference to remove extrusions, formed by reacting pockets of metal in the metal silicide barrier layer and the metal silicide conductive layer with oxygen and nitrogen, on the exposed sides of the barrier layer and the conductive layer. Also, because neither the Douglas reference, nor the Abido reference, teaches or suggests any extrusion, formed by reacting pockets of metal in the metal silicide barrier layer and the metal silicide conductive layer with oxygen and nitrogen, on the exposed side of the barrier layer and the conductive layer, the Examiner has not provided prior art that teaches all the claim limitations.

The references cited by the Examiner do not disclose, teach, or suggest a semiconductor structure comprising a barrier layer above a polysilicon layer, the barrier layer comprising metal silicide and metal-rich areas, or tungsten silicide and tungsten-rich areas, where the metal-rich areas and the tungsten-rich areas form metal oxynitride, and tungsten oxynitride, respectively, in the presence of oxygen and nitrogen. The references cited by the Examiner do not disclose, teach, or suggest that the metal oxynitride and the tungsten oxynitride expand relative to the barrier layer to extend outwardly from the sides of the barrier layer, and that the barrier layer has substantially etched metal oxynitride extrusions or tungsten oxynitride extrusions, respectively, formed on the side thereof.

Further, the references cited by the Examiner do not disclose, teach, or suggest a conductive layer above the barrier layer, the conductive layer comprising metal silicide and metal-rich areas, or titanium silicide and titanium-rich areas, where the metal-rich areas and the titanium-rich areas form metal oxynitride, and titanium oxynitride, respectively, in the presence of oxygen and nitrogen. The references cited by the Examiner do not disclose, teach, or suggest that the metal oxynitride and the titanium oxynitride expand relative to the conductive layer to extend outwardly from the sides of the conductive layer, and that the conductive layer has substantially etched metal oxynitride extrusions or titanium oxynitride extrusions, respectively, formed on the side thereof.

Applicant asserts that Claims 1 and 13 are not obvious in view of the Douglas and Abido references. Applicant therefore respectfully submits that Claims 1 and 13

are patentably distinguished over the cited references and Applicant respectfully requests allowance of Claims 1 and 13.

Claims 2 and 8-12

Claims 2 and 8-12, which depend from Claim 1, are believed to be patentable for the same reasons articulated above with respect to Claim 1, and because of the additional features recited therein.

Claims 14 and 20-24

Claims 14 and 20-24, which depend from Claim 13, are believed to be patentable for the same reasons articulated above with respect to Claim 13, and because of the additional features recited therein.

Claims 25, 34, and 43

In an embodiment of the invention, an etch removes metal oxynitride extrusions protruding from the sides of the metal silicide layer in a semiconductor stack. The extrusions form by reacting pockets of metal found in the metal silicide layers with oxygen and nitrogen from the semiconductor processing steps.

In contrast, Douglas appears to teach forming a titanium oxynitride layer over a titanium silicide layer and etching to remove all filaments of the titanium oxynitride layer from the upper surface of the underlying titanium silicide layer. Douglas does not teach forming a tungsten silicide layer, nor does Douglas teach metal oxynitride extrusions forming on the exposed sides of the semiconductor structure by reacting metal-rich areas of the metal silicide layer with oxygen and nitrogen from semiconductor processing steps. While Abido teaches forming a tungsten silicide barrier layer, Abido does not appear to teach any extrusions forming on the semiconductor device.

Thus, there is no suggestion or motivation to combine the Douglas reference with the Abido reference to remove extrusions formed by reacting pockets of metal, tungsten, and titanium in the metal silicide layer, the tungsten silicide layer, and the titanium silicide layer, respectively, with oxygen and nitrogen on the exposed sides of the metal silicide layer, the tungsten silicide layer, and the titanium silicide layer, respectively. Also, because neither the Douglas reference, nor the Abido reference, teaches or suggests any extrusion formed by reacting pockets of metal, tungsten, and titanium in the metal silicide layer, the tungsten silicide layer, and the titanium silicide

layer, respectively, with oxygen and nitrogen on the exposed sides of the metal silicide layer, the tungsten silicide layer, and the titanium silicide layer, respectively, the Examiner has not provided prior art that teaches all the claim limitations.

The references cited by the Examiner do not disclose, teach, or suggest a semiconductor stack comprising a metal silicide layer having metal-rich areas, a tungsten silicide layer having tungsten-rich areas, or a titanium silicide layer having titanium-rich areas, where the metal-rich areas, the tungsten-rich areas, and the titanium-rich areas form metal oxynitride, tungsten oxynitride, and titanium oxynitride, respectively, in the presence of oxygen and nitrogen.

The references cited by the Examiner do not disclose, teach, or suggest that the metal oxynitride, tungsten oxynitride, and titanium oxynitride expand relative to the metal silicide layer, the tungsten silicide layer, and the titanium silicide layer, respectively, to extend outwardly from the metal silicide layer, the tungsten silicide layer, and the titanium silicide layer, respectively, to form metal oxynitride extrusions, tungsten oxynitride extrusions, and titanium oxynitride extrusions, respectively.

The references cited by the Examiner do not disclose, teach, or suggest that the metal silicide layer, the tungsten silicide layer, or the titanium silicide layer has substantially etched metal oxynitride extrusions, tungsten oxynitride extrusions, and titanium oxynitride extrusions, respectively, formed on the side thereof,

Applicant asserts that Claims 25, 34, and 43 are not obvious in view of the Douglas and Abido references. Applicant therefore respectfully submits that Claims 25, 34, and 43 are patentably distinguished over the cited references and Applicant respectfully requests allowance of Claims 25, 34, and 43.

Claims 26, 32, and 33

Claims 26, 32, and 33, which depend from Claim 25, are believed to be patentable for the same reasons articulated above with respect to Claim 25, and because of the additional features recited therein.

Claims 35, 41, and 42

Claims 35, 41, and 42, which depend from Claim 34, are believed to be patentable for the same reasons articulated above with respect to Claim 34, and because of the additional features recited therein.

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Claim 44

Claim 44, which depends from Claim 43, is believed to be patentable for the same reasons articulated above with respect to Claim 43, and because of the additional features recited therein.

REJECTION OF CLAIMS 3-5, 7, 15-17, 19, 27-29, 31, 36-38, 40, 45-47, and 49 UNDER 35 U.S.C. § 103(a)

The Examiner rejected Claims 3-5, 7, 15-17, 19, 27-29, 31, 36-38, 40, 45-47, and 49 under 35 U.S.C. § 103(a) as being unpatentable over Abido in view of Douglas and further in view of Schrems. In view of the above discussion, Applicant respectfully traverses this rejection.

Claims 3-5, and 7, 15-17, and 19, 27-29, and 31, 36-38, and 40, 45-47, and 49, which depend from Claims 1, 13, 25, 34, and 43, respectively, are believed to be patentable for the same reasons articulated above with respect to Claims 1, 13, 25, 34, and 43, respectively, and because of the additional features recited therein.

REJECTION OF CLAIMS 6, 18, 30, 39, and 48 UNDER 35 U.S.C. § 103(a)

The Examiner further rejected Claims 6, 18, 30, 39, and 48 under 35 U.S.C. § 103(a) as being unpatentable over Abido in view of Douglas and further in view of Schrems and Tsuchida. In view of the above discussion, Applicant respectfully traverses this rejection.

Claims 6, 18, 30, 39, and 48 which depend from Claims 1, 13, 25, 34, and 43, respectively, are believed to be patentable for the same reasons articulated above with respect to Claims 1, 13, 25, 34, and 43, respectively, and because of the additional features recited therein.

REQUEST FOR TELEPHONE INTERVIEW

Pursuant to M.P.E.P § 713.01, in order to expedite prosecution of this application, Applicant's undersigned attorney of record hereby formally requests a telephone interview with the Examiner as soon as the Examiner has considered the

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effect of the arguments presented above. Applicant's attorney can be reached at (949) 721-2998 or at the number listed below.

CONCLUSION

Applicants have endeavored to address all of the Examiner's concerns as expressed in the outstanding Office Action. In light of the above remarks, reconsideration and withdrawal of the outstanding rejections is requested.

Please charge any additional fees, including any fees for additional extension of time, or credit overpayment to Deposit Account No. 11-1410.

Respectfully submitted,

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Dated: 3/7/05

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